QUARTERLY REPORT

1.	Contract No.:	DAMD17-91-C-1081
2.	Report Date:	28 August 1992
3.	Reporting Period:	16 May 1992 through 15 August 1992
4.	Principal Investigator:	Dr. Robert W. Verona
5.	Telephone Number:	(205) 598-6389
6.	Institution:	UES, Inc. 4401 Dayton-Xenia Road Dayton, Ohio 45432
7.	Project Title:	Development of Data Packages on the Human Visual Response with Electro-Optical Displays.

8. Current staff, with percent effort of each on project:

NAME	TITLE	HOURS*	% OF EFFORT
Dr. Robert W. Verona	Engineering Psychologist	452	90%
Dr. Victor Klymenko	Research Psychophysicist	484	96%
Mr. Howard H. Beasley	Electronics Technician	489	97%
Mr. John S. Martin	Electro-optic Technician	471	93%

* 504 Hours were available during this reporting period not including holidays. The above hours are the actual hours worked (sick leave and vacation time have been subtracted).

9. Contract expenditures to date:

Personnel	$285,688.13	Equipment & Supplies	$3,480.89
Travel	$ 3,647.67	Other	$2,791.00
		TOTAL*	$295,607.69

*Does not include facilities capital and G&A expense.

10. Comments on administrative and logistical matters.

None.

11. Scientific Progress:

Physical Measurements:

The prototype electro-optical systems that are being characterized contain both image intensifiers (I^2s) and cathode ray tubes (CRTs). The first year's efforts concentrated on CRT characterizations. This quarter's efforts were focused on I^2 characterizations. The first step involved studying the various I^2 measurement procedures contained in reports and articles generated by the USAF Armstrong Aerospace Medical Research Laboratory, USA Directorate for Night Vision and Electro-optics, I^2 vendors, and military specifications.

The standard I^2 tube and device parameters being measured include: gain, objective resolution [modulation transfer function(MTF)], maximum contrast, spectral sensitivity, and output luminance uniformity. These are measured over a range of input light conditions from full moon to overcast starlight. Dynamic MTF and signal-to-noise measurements are being developed also. These are temporal measures and more dependent on the measurement equipment characteristics than the static measurements. The following paragraphs contain a summary of progress.

The photometric equipment used to characterize CRTs was also suitable to characterize the I^2 tubes. The I^2 tubes, however, required a different type of input stimulus. Electronically generated stimuli are used for CRT measurements, but low light level optical stimuli are required for I^2 tube measurements. Significant improvements had to be made to the light control devices and the procedures in the measurement area, since even very low level stray light contaminates I^2 measurements.

Light gains of roughly 4,000 to 6,500 were measured on a prototype tube without fiberoptics and 2,300 to 5,000 on an ANVIS like tube with fiberoptics; both tubes had P-43 phosphor screens. The standard ANVIS tube with P-20 phosphor exhibited gains between 3,000 and 3,200 over the same light level range, moonlight to starlight. The gain measurements at higher light levels were limited by the automatic brightness control (ABC) and/or micro-channel plate saturation. This gain reduction caused a contrast loss since the highlight luminance was limited and the background luminance was not constrained.

The image contrast measured on three different I^2 tubes remained constant for each tube over a wide range of input light levels (full moon to starlight). However, the contrasts on each tube differed. The prototype tube with no fiberoptic output exhibited about 5% lower contrast output

than the tubes with a fiberoptic output. A greater difference had been expected. The highlight luminance of the tube without fiberoptics was almost twice as high as the other tubes. This difference was most significant at moonlight conditions when the luminance output was in the tens of footlambers. At starlight the ratio was the same, but the effect was much less significant.

We measured the MTF of three different I^2 tubes and found the tube without a fiberoptic output had a 15 to 25% higher cut-off frequency than the tubes with the fiberoptic output. But, the modulation contrast at a low spatial frequency (about 8 cycles/display width) was 5% lower than tubes with the fiberoptic output. The MTF measurement software normalizes the modulation contrast to 100% at a low spatial frequency. When the MTF curve is normalized to the actual measured modulation contrast rather than 100%, the resultant MTF curve performance prediction is much more realistic. The measured data indicate that the elimination of the fiberoptic output reduces the modulation contrast at low spatial frequencies to about 90% (equivalent to eight gray scales). This modulation loss has less of an effect at the higher spatial frequencies. The spatial frequency cut-off is actually improved when the fiberoptics are eliminated.

Generally, there were only small differences among the MTFs as a function of light level. The noise level at the higher spatial frequencies increased with decreases in light level, and this noise may have masked some small MTF differences. These small MTF differences would not explain the large subjective performance differences evident with a reduction in light level.

I^2 data were collected until the results could be reproduced as exact as measurement tolerances would permit. The resulting methodology and procedures that have been developed can be used with confidence.

The laboratory space, originally designated for the psychophysical studies, is being used for I^2 system tests that require a long throw distance. This room has been equipped with some light control curtains over the door entrance, a white background screen for resolution charts, various resolution charts with different formats and contrasts, angular measurement devices, and variable intensity lighting that maintains color temperature (spectral distribution). Additional enhancements will be made as needed to satisfy system test requirements.

Psychophysical Measurements:

In the last quarter, the implementation of a fully functional general purpose visual perception laboratory for the testing of binocular and/or stereoscopic vision was completed. The lab can be used also to investigate other areas of visual perception and visual cognition. The basic components of the lab include a computer graphics workstation and an optical table configuration and subject booth.

The computer graphics workstation consists of the computer for generating stimuli and recording and analyzing subject data, and the monitor for presenting the stimuli. On the workstation we have written software which does the following: It presents visual stimuli with precisely controlled spatial and temporal characteristics in an experimental setting, where the subject's responses are recorded and adaptively used to determine the next stimulus. Two sets of programs were written, one in which the subject sets the threshold, and one in which the computer determines the threshold based on the subject's ongoing responses. Several versions of the software for timing and data consistency have been tested and the software was modified accordingly, in one case by switching from an adjustment procedure to a method of limits procedure, and in another case by reducing the number of adaptive staircases in a planned experimental session. Additional software was written to output descriptive statistics of the subject's responses. Also several demonstration programs were written to show convergent and divergent binocular overlap and the luning effect produced by these display modes with and without demarcation of the binocular/monocular border. Several test programs were written to investigate the workstation attributes. This was necessary because psychophysical experiments typically require more precision (timing etc.) than users typically expect from this type of workstation. The hardware/software graphics capabilities and limitations of this workstation have been characterized so experiments can be designed within those parameters. This includes the on-line image storage capacity and the number and complexity of images which can be stored, and the transition speed between stimuli. Additional, graphics software was written to aid in optical table alignment, to measure subject phoria, and to introduce eye convergence into the images.

The optical table configuration consists of the graphics monitor and two sets of mirrors designed to direct two images to a pair of binoculars. A number of alignment/calibration procedures have been tested for reliability for the optical table configuration. Mirror alignment procedures have been fine tuned using a laser pointer modified for that purpose. A binocular focusing procedure using a diopterscope has been instituted, and the interpupillary distance (IPD) calibration has been fine tuned. The later involves individual adjustments of two mirrors and the binoculars based on each subject's IPD measurements. The binocular IPD adjustment system was modified to reduce positioning variations. Two mirrors were modified by the addition of micrometer rotational positioning and vertical locking mechanisms.

In addition, the optical table and adjacent subject booth were covered with a fabricated steel frame covered with black cloth to protect the optical table components and block out stray light. Also, a light baffle was fabricated and installed to prevent crosstalk between the two optical trains on the optical table. An air conditioning vent and a chin/head rest was installed in the subject booth. An external monitor linked via a scan converter was added to the system to allow external viewing of the stimuli since the subject monitor is now covered with a metal frame. A computer backup procedure was instituted in the event of a computer crash.

The protocol underwent several iterations incorporating comments from various members of the community including Dr. Wiley. The protocol was presented to the Scientific Review Committee (SRC). Based on their critique, which included eliminating Experiment 2 as a separate experiment by combining some of its features with Experiment 1, the protocol was redesigned, and a draft revision submitted to Dr. Wiley. After incorporating the comments from Dr. Wiley, the revision was distributed to members of the SRC.

12. Milestones:

Measurement procedures for I^2 tubes and devices are being documented and will be released next quarter as a USAARL technical report. The technical report will also contain sample data from the tubes and devices we have tested.

The focus will shift back to CRTs next quarter and to the development of dynamic MTF procedures and software. Once satisfied with the results of the CRT dynamic tests, those procedures will be used to measure I^2 tube dynamic MTFs. A fast response miniature CRT has been proposed for use as a dynamic light input stimulus for the I^2 tube/system. Moving test patterns can be generated electronically on the CRT and imaged on the I^2 tube's photocathode.

Most of the next quarter will be used to collect and analyze psychophysical data. Some portions of the technical report will be written in conjunction with the data collection and analyses.

An abbreviated protocol will be initiated during the next quarter for more psychophysical tests related to the monocular/binocular boundary in the partial overlap display modes. During the next quarter there will be more software development for the HP9000. The current stimulus generation capabilities will be enhanced to provide the additional flexibility needed for the new cognitive and perceptual tests.